Proposal for the Continuing Operation of RIACS

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Research Institute for Advanced Computer Science
NASA Ames Research Center

RIACS Technical Report TR-85.18

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This report contains the text of the proposal submitted to the University Affairs Office at NASA Ames Research Center to continue the operation of RIACS under the formalism of a Cooperative Agreement.

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1. Scope of Work and Objectives

The Research Institute for Advanced Computer Science (RIACS) was established in June 1983 at the NASA Ames Research Center, Moffett Field, California, under a three-year contract (No. NAS2-11530) to the Universities Space Research Association (USRA). USRA herein proposes to continue the operation of RIACS, through January 1989, under the instrument of a Cooperative Agreementwith the NASA Universities Affairs Program. Dr. Peter J. Denning will continue as Director and Principal Investigator. The RIACS facility will continue to develop and fulfill five main purposes:

1. RIACS will conduct independent computer science research that supports problem-solving capabilities in the scientific and engineering fields of interest to the aerospace regime. These fields are, primarily, concurrent processing, distributed systems, and artificial intelligence. The research program will comprise two closely related parts: the core program, funded through the proposed Cooperative Agreement, and the task program, funded through separate, supplemental Cooperative Agreements.

2. RIACS will provide an interface between the Ames Research Center (ARC) and the computer science research community in academic and industrial research laboratories. RIACS will strengthen the ties between ARC and these communities by assisting in the development of programmatic activities in computer science and technology.

3. RIACS will improve cooperative research efforts of government, industry, and academia toward the solution of problems requiring advanced computational facilities.

4. RIACS will enhance technology transfer between ARC staff and the computer science research community by conventional scientific means, including rapid dissemination of technical reports by institute personnel, presentations at symposia, publication in appropriate journals, and seminars or workshops at the ARC.

5. RIACS will establish and maintain a leading edge research computer laboratory and computing facility comprising both hardware, software, and networks appropriate for the purposes stated herein.

The RIACS facility will conduct other activities as appropriate to meet these goals — for example, lecture and visitor programs, consultations and collaborations with ARC staff on topics on computer science and applied mathematics, hosting of conferences and symposia, and innovative collaborations with outside institutions. In addition, RIACS personnel may lend support to local universities through the direction of dissertations, service on research committees, participation in research seminars, and consulting or adjunct professorships.

2. Continuation of the RIACS Facility

Except as otherwise specified in the Cooperative Agreement, RIACS will furnish all personnel, services, equipment, and materials needed to continue operating at Moffett Field, California, the facility outlined above and described more fully in the attached Annual Report for 1984. RIACS will undertake, independently or in conjunction with NASA, computer science investigation of new or novel impression pertaining to the aerospace regime. Part of this research will be undertaken through the funds provided by the proposed Cooperative Agreement; this part will be called "core research". Additional research may be undertaken through separately funded Cooperative Agreements on topics related to research in the aerospace regime and supportive of the core research program; this part will be called "task research."

Appendix A contains a copy of the Statement of Work (SOW) that was part of the original RIACS contract (1983-85).

2.1. General Requirements

The RIACS Facility as continued by USRA will satisfy three general requirements:

(1). RIACS will continue to be located in Government-furnished property at NASA-Ames Research Center, Moffett Field, California, and USRA will be allowed the on-site use of certain property as set forth below, together with property identified in remaining provisions of the Cooperative Agreement. The control and accountable record keeping for such property shall be retained by the Government pursuant to the general provisions for Cooperative Agreements. The ARC will provide:

(i)   Office and work area space, utilities such as telephones, water, electricity, and other municipal type services.

(ii) Janitorial services, security, building maintenance, and support services such as reproduction.

The above will be of comparable quantity and quality to that provided to NASA Civil Servants of the same professional status, e.g., senior scientist. For the purposes of this paragraph, the RIACS Director will be regarded as having the same status as the Directors of Ames Directorates (single letter codes).

(2). RIACS will be staffed on a full-time basis with personnel who shall perform Core Operations, Task Operations, and Technology Transfer Operations. No RIACS personnel will be used to supplant Federal employees, or used in lieu of Federal employees, nor will performances by them result in the displacement of Federal employees or in the impairment of existing contracts for services. Neither RIACS personnel nor Federal personnel will control or direct the work of personnel employed by their counterparts. The fulfillment of RIACS purposes will be the sole responsibility of USRA.

(3). RIACS will be allowed use of NASA-ARC software, computers and computational facilities located at Ames Research Center. The exact Date(s) and time(s) for use of ARC computers shall be mutually agreed upon by the RIACS Technical Monitor (or Alternate) for core research and by the individual task technical monitors for task research.

2.2. Operations

2.2.1. General

In general, RIACS will focus upon basic and applied research including technology transfer in areas of computer science, computer engineering, numerical analysis and computer applications in the aerospace regime. These operations are threefold and encompass:

(i) CORE OPERATIONS under which RIACS will maintain a staff consistent with available NASA core funding to manage the Facility established herein and to perform either at the Facility or elsewhere independent research in areas contemplated above.

(ii) TASK OPERATIONS under which RIACS will undertake specific, or directed, research projects proposed and funded separately from Core Operations. Task Operations will be related to the goals of the Core Research Program. Supplemental Cooperative Agreements for tasks will typically cover periods from a few months to two years.

(iii) TECHNOLOGY AND TRANSFER OPERATIONS under which RIACS will, in conjunction with, and under policies prescribed by NASA, transfer technology developed, or arising from, the proposed Cooperative Agreement.

2.2.2. Core Operations

The Core Operations will engage research in areas of computer science research deemed to be of first priority to NASA. These are the areas with the potential of producing significant advancements in capabilities for large scale computational physics, expert systems technology for space and ground applications, artificial intelligence, control theory and the life sciences. RIACS will accord special emphasis to research that supports NASA endeavors in computational fluid dynamics, computational chemistry, atmospheric modeling, astrophysics, and the space station. The pertinent areas of computer science include:
(a) advancing the state-of-the-art through basic research in computer architectures, especially concurrent processing and fault tolerant architectures, both hardware and software aspects; and in the theory of computation including analysis of algorithms and their mapping to various architectures; (b) research to adapt advances in systems analysis and engineering, software engineering, programming languages, data base management, computer graphics, and artificial intelligence to NASA needs; (c) development of symbolic processors, other non-Von-Neumann machines, and natural language interfaces; and
(d) maintaining cognizance of research results in other areas of computer science

which may benefit NASA.

2.2.2.1. Long Term Core Research Goals

In pursuit of these general goals, a more focused research program was formulated and approved by the RIACS Alternate Technical Monitor (J. O. Arnold) in July, 1983. This program has been referred to as Project "R" in RIACS documents, brochures, and reports.

The goal of Project "R" is very high level support of entire process of scientific investigation from problem formulation to results dissemination. Three levels of computer systems are required to support the process of scientific investigation:

1. SCIENTIST'S AIDE: An intelligent user interface system that deals with the user in language, concepts, pictures of the discipline.

2. CONCURRENT PROCESSING SYSTEMS: Virtual machines and software parts libraries for various models of parallel computation.

3. HARDWARE AND NETWORKS: The actual machinery on which computations are performed.

Project "R" focuses on systems at Levels 1 and 2. Level 2 has received most of the attention so far. The capabilities envisioned in computer systems that meet these needs are:

1. High speed numeric calculation via parallel processing.

2. Rapid solution of partitionable problems using distributed processing.

3. Computing environment to permit rapid development of distributed computations requiring heterogeneous elements.

4. New algorithmic techniques and functional languages to exploit massive parallelism and distributed networks.

5. Classification of problems by best combinations of domains, computational models, and architectures.

6. User interfaces to allow scientists to develop tools and results in their own domains, interfaces tailored to those domains, allowing access to capabilities of many machines.

7. Single user environment integrating symbolic, numeric, and other types of processing systems.

8. Multimedia telecommunications integrated with the computing environment to permit large scale collaboration on scientific research.

2.2.2.2. 1986 Core Research Goals

During 1986, we hope to achieve the following. (The names of responsible staff members are in parentheses.)

1. The Intel hypercube will be fully operational and serving as focal point for research and seminar in new algorithms for CFD and CC. The goal is to discover how many kernel problems from CFD and CC can be solved with algorithms that run (almost) N times faster when partitioned for N processors. At least three problems will be evaluated. (Raugh, Chan)

2. Performance tools capable of measuring processor and network loads on the hypercube will be implemented and used to instrument hypercube programs. Measurements will support parallel algorithm research noted above and will assist in debugging parallel programs. (Adams)

3. A suite of programs that load parallel multiprocessors in various ways will be constructed and used to quantitatively compare parallel machines such as the Sequent multiprocessor and Intel hypercube. (Brown, Adams, Denning)

4. Concurrent C will be made available for experimentation and use in programming hypercube and other multiprocessors. (Brown)

5. Stage 1 of a distributed program composition system will become operational in the form of a graphical shell. It can be used to program computations that require multiple, heterogeneous UNIX machines, for example SUN workstations and the Cray-2 computers. (Brown, Denning)

6. Simulators for the Sparse Distributed Memory (SDM) will be completed and under test. The SDM is a memory of 1 million locations, each containing 1000 bytes; addresses of 1000 bits select groups of memory cells within Hamming distance of 451 bits. This memory organization is well suited for applications in robotics and autonomous systems. Simulators are intended for both the Intel hypercube and the Symbolics LISP machine. In cooperation with Mike Flynn at Stanford, a breadboard model of the memory will be constructed. (Kanerva, Raugh)

7. An image enhancement application will be implemented on the hypercube partly to study of new algorithms for processing images and partly to study parallel algorithms that load the machine unequally at different points (e.g., more computation is required in regions of the image containing more features). (Adams)

8. A study of the ability of expert systems to aid CFD research will be conducted and a report issued. (TBD)

9. Prototypes for multimedia mail and conferencing systems tailored to the needs of the scientific community will be developed. A report on architectures that take into account the needs of this community in access control and privacy will be completed. (Leiner)

10. Bounds on the performance of distributed algorithms will be explored. These bounds will be stated in terms of the communication needs of the algorithms and the capacities of the network. (Leiner, Denning)

Milestones for research in 1987 and 1988 will be proposed and approved by the the Technical Monitor (or Alternate) no later than one month prior to the start of each calendar year.

2.2.3. Task Operations

The Task Operations will undertake additional projects, approved by the Technical Monitor (or Alternate). Each such project will be embodied in a separate Cooperative Agreement that describes the work and deliverable items, if any; budgetary and labor-hour estimates for the project ; the completion date; and special instructions or information. It is intended that each supplemental Cooperative Agreement will be regarded as a fixed-price agreement for completing the work described therein and that the procedure for entering such agreements should be simple and expeditious. The technical monitor of a supplemental Cooperative Agreement will be specified in the proposal and will generally

not be the same as the Technical Monitor (or Alternate) for Core Research Operations.

2.2.4. Technology Transfer Operations

Technology Transfer Operations will include any and all additional activities approved by the Technical Monitor (or Alternate) that support the purposes of the RIACS facility.

3. Management Approach

A. The core budget of RIACS will be used primarily to support the Core Research Program and the laboratory facility. Supplemental Cooperative Agreements will be used primarily to support extentions to the core program, sabbatical visitors, consultants, and other relevant special research projects. All personnel will report to the RIACS Director in conformity with USRA policies.

B. A core-supported research scientist must be approved, in advance of an offer of employment, by the Technical Monitor (or Alternate). A research scientist supported in a supplemental Cooperative Agreement must be approved, in advance of an offer of employment, by the technical monitor of that Agreement.

4. Facility

RIACS will establish and maintain a laboratory and computing facility (hardware, software, and networks) capable of supporting the research and operations envisaged herein. This facility will be paid for by core and task funds as appropriate and may be augmented by other funding and by industrial donations. A description of the facility and plans for the future will be submitted with the Annual Report each year and will be approved before implementation by the Technical Monitor (or Alternate).

The proposed research computing equipment for 1986, for which funding is sought in the budget, is listed in Table 1.

TABLE 1: New Equipment for 1986.

Qty	Description	Approx. Cost
5	Workstations,to support workstation-related research and tasks	$90,000
1	Color printer	$8,000
1	Graphics terminal or workstation (E&S PS330 or equivalent)	$65,000
10	Modems	$8,000
	Lab equipment	$14,000
	Upgrades to existing systems, including high-speed disk controller, add-on memory, processors, new buss.	$53,000
	LAN upgrades, including wiring RIACS offices for LAN and hooking into the ARC network	$12,000

	TOTAL	$250,000

5. Review and Reporting

A. RIACS will report semiannually as follows. By the end of January each year, RIACS will submit a draft of an annual report on research and operations during the preceding calendar year. On request by the Technical Monitor, the substance of this report will be presented to ARC management and scientific personnel at a public presentation.

B. During August of each year, RIACS will conduct an oral review of its research and operations for ARC management and scientific personnel. Copies of the handouts and slides uses at this presentation will be provided to the Technical Monitor (or Alternate) and will constitute the report.

6. Science Council

A. A Science Council shall be appointed by USRA and shall report to the Association on the scientific activity of the Institute. In order to help assure a free and fluent exchange of ideas, concepts, and information between RIACS and ICASE (USRA's institute at the Langley Research Center), the Science Council for RIACS shall have overlapping membership with the Science Council appointed to serve ICASE. The activities of the Science Council will be funded by the Association as part of its General and Administrative expenses.

B. The Science Council shall advise the RIACS Director on research projects, priorities, and resource requirements (personnel and facilities). It shall meet periodically at the call of its convener with the RIACS Director to review the research, progress of the Institute, reports, publications, and other matters that would affect or influence the purposes of RIACS.

7. Technical Monitor

A. The primary Technical Monitor of this project will be the Chief Scientist of the ARC. (Jack Nielsen is the Technical Monitor at the time of this proposal.)

B. The Alternate Technical Monitor will be an ARC manager of branch chief rank or higher, appointed by the Technical Monitor with the concurrence of the ARC Director and the RIACS Director. (James O. Arnold is the Alternate Technical Monitor at the time of this proposal.)

8. Personnel

A. The Principal Investigator of the project will be Dr. Peter J. Denning, the Director of RIACS. A curriculum vitae and biography are attached.

B. Other scientists employed by RIACS will continue. Biographies are listed in the Annual Report for 1984.

9. Classified Research

The program of the Institute will not involve classified material. However, it is realized that certain individuals associated with the Institute may find it necessary or advisable to maintain a security clearance in order to have convenient access to facilities which they need in their work. The Ames Research Center will assist and coordinate in obtaining security clearances for designated individuals.

APPENDIX A

Purpose of the RIACS Facility

Originally "Appendix A" to the Statement of Work
in the RIACS Contract (NAS2-11530, 1983-85)

The RIACS facility will:

1. Provide an interface between Ames Research Center and the academic community and will serve as a center of cooperation in activities conducted primarily in advanced computer science and engineering and secondarily in applied mathematics and the application of computers to the solution of scientific and engineering problems of concern to the Agency and Ames Research Center.

2. Conduct independent research activities with the objective of developing concepts, techniques, or prototypes in computationally related disciplines to enhance problem-solving capabilities in the scientific and engineering fields of interest to the Aerospace Regime.

3. Improve cooperative research efforts of government, industry, and academia toward the solution of problems requiring advanced computational facilities.

4. Enhance technology transfer between universities, industry and other government agencies by conventional means, including encouragement of the rapid dissemination of preprint reports by institute personnel, presentations at symposia and publications in appropriate journals.

5. Strengthen ties between the general academic and industrial communities and the staff of the Center in order to further develop in-house programmatic activities in computer science and technology.

Finally, the RIACS Facility also may carry out a variety of additional activities, including lecture and visitor programs, consultation and collaborations with Ames Research Center on topics in the field of computer science and applied mathematics. In addition, RIACS personnel may lend support to local universities through the direction of dissertations, service on research committees, and participation in research seminars.

Science Council:

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